Design Example
for
A Multi-family Residential Site

DESIGN EXAMPLE

FOR

A MULTI-FAMILY RESIDENTIAL SITE

I. Given

A. Acreage

1. Total = 95.0 ac

2. Impervious

a. Buildings (roofs) = 9.3 ac

b. Roads and parking = 41.7 ac

3. Lakes = 10.0 ac

4. Pervious = 34.0 ac

B. Minimum elevations

1. Roads and parking = 9.0' NGVD

2. Floors = 11.5' NGVD

C. Design storm allowable discharge has been determined to be 37 cfs.

D. Water level elevations

1. Average wet season water table in the vicinity of the lakes = 5.5' NGVD

2. Receiving body water level has been determined not to affect discharge rates.

(Note: Proposed minimum road grade (9.0' NGVD) is more than 2 ft above the average wet season water table, or control elevation, of 5.5' NGVD. This is a criteria which is occasionally overlooked in initial designs.)

E. Rainfall amounts (24-hour)

1. Roads (10-year) = 9.0 inches

2. Design (25-year) = 11.0 inches (this will be adjusted to a 72-hour event later)

3. Floors (100-year) = 14.0 inches (this will be adjusted to a 72-hour event later)

SITE PLAN VIEW
(N.T.S.)

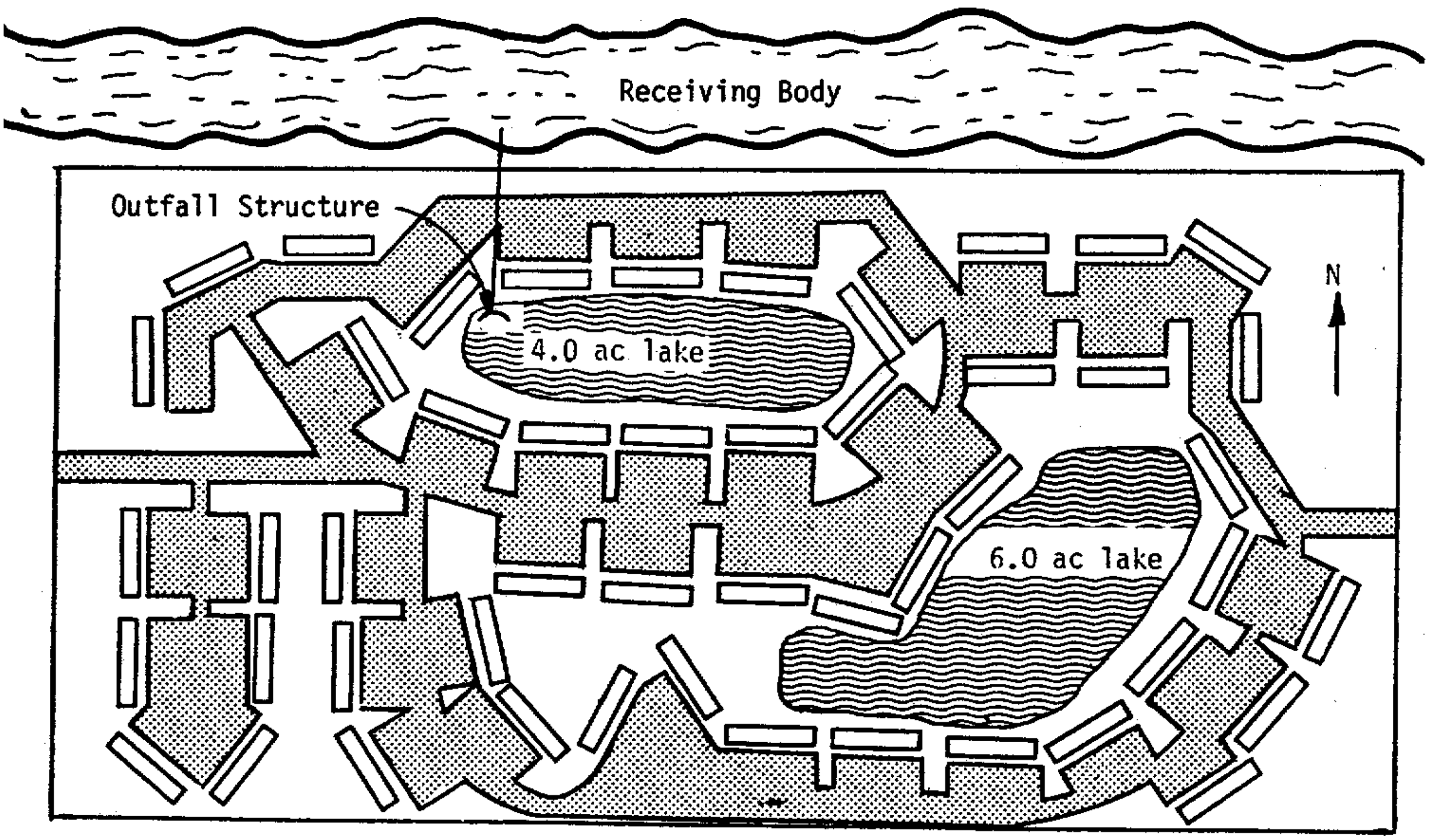


Figure XG-1

II. Design Criteria

A. Quality

1. Since this is proposed as a wet detention system, then whichever is the greater of:

   a. The first inch of runoff from the entire site, or

   b. The amount of 2.5 inches times the percentage of imperviousness.

2. If this residentially-zoned site were discharging directly into sensitive receiving waters (example: Outstanding Florida Waters), then it might have to provide at least 0.5 inch of dry detention or retention pretreatment. (This will be discussed later in more detail.)

3. Any detention system shall be designed to discharge not more than 0.5 inch of the detained volume per day. A V-shaped configuration is desirable.

B. Quantity

1. The allowable peak discharge is 37 cfs during a 25-year 3-day storm.

2. First floors are desired to be no lower than elevation 11.5' NGVD.

3. Roads and parking are desired to be no lower than elevation 9.0' NGVD.

III. Computations

A. Quality

1. Compute the first inch of runoff from the developed project:

   = 1 in. x 95 ac x 1 ft/12 in.

   = <u>7.9 ac-ft</u> for the first inch of runoff

2. Compute 2.5 inches times the percentage of imperviousness:

   a. Site area for water quality pervious/impervious calculations <u>only</u>:

      = Total project - (water surface + roof)

      = 95 ac - (10 ac + 9.3 ac)

      = 95 ac - 19.3 ac

      = <u>75.7 ac</u> of site area for water quality pervious/impervious.

b. Impervious area for water quality pervious/impervious calculations <u>only</u>

= (Site area for water quality pervious/impervious) - pervious

= 75.7 ac - 34.0 ac

= <u>41.7 ac</u> of impervious area for water quality pervious/impervious

c. Percentage of imperviousness for water quality:

= (Impervious area for water quality/Site area for water quality) x 100%

= (41.7 ac/75.7 ac) x 100%

= 55% impervious

d. For 2.5 inches times the percentage impervious:

= 2.5 in. x 0.55

= <u>1.38 in.</u> to be treated.

e. Compute volume required for water quality detention:

= inches to be treated x (total site - lakes)

= 1.38 in. x (95 ac - 10 ac) x 1 ft/12 in.

= <u>9.8 ac-ft</u> required detention storage.

3. Since the 9.8 ac-ft are greater than the 7.9 ac-ft computed for the first inch of runoff, the volume of <u>9.8 ac-ft</u> controls.

(Note: The system proposed is wet detention, so no volume reductions are possible.)

4. Sidelight: Pretreatment

a. If this project were discharging directly to a sensitive receiving body, it would have to provide at least 0.5 inch of <u>dry</u> detention or retention pretreatment, because it is more than 40% impervious. The receiving body is not a sensitive one, but the numbers will be computed now, strictly to illustrate the process.

b. Compute 0.5 inch of pretreatment

= 0.5 in. x (total site - lakes)

= 0.5 in. x (95 ac - 10 ac) x 1 ft/12 in.

= <u>3.5 ac-ft</u> required for pretreatment.

This volume would be required regardless of whether dry retention or detention were utilized. It would be considered as available storage for the road, design, and minimum floor storms if it were a detention system, or utilized properly-designed exfiltration trench. It would not be considered as available for storage if it were a retention system which relied only on natural percolation and evaporation as the mechanisms for re-achieving a dry state.

c. Compute the resulting required lake volume:

= Total required detention - pretreatment

= 9.8 ac-ft - 3.5 ac-ft

= <u>6.3 ac-ft</u> required lake volume.

B. SCS Curve Number

1. Even though the control elevation is 5.5' NGVD, it is assumed that the water table will vary from 5.5' NGVD at the lakes to about 7' NGVD at the project boundaries. Consequently an average site water table elevation of 6.25' NGVD will be assumed.

2. The average site finished grades will vary from the lowest inlets in the parking lots (9.0' NGVD), to a little above the 11.5' NGVD floor elevations (say 12' NGVD). Therefore, average site grade elevation will be 10.5' NGVD.

3. The average depth to water table will be

= average site grade elevation - average site water table elevation

= 10.5' NGVD - 6.25' NGVD

= <u>4.25 ft</u>; 4 ft is the maximum depth of percolation assumed possible in three days for the soils on this site.

4. From the soil storage table, assuming the 25% compaction and 4 ft to the water table, up to 8.18 inches of moisture can be stored in the soil under pervious areas.

5. Compute available soil storage

= storage available x pervious areas

= 8.18 in. x 34 ac x 1 ft/12 in.

= <u>23.2 ac-ft</u> available soil storage onsite.

6. Convert available soil storage to site-wide moisture storage, S

S = available soil storage onsite/site area

= ((23.2 ac-ft)/(95 ac)) x (12 in./1 ft)

= <u>2.93 in.</u> of site-wide soil storage, S

7. SCS Curve Number, CN

$$CN = 1000/(S + 10)$$
$$= 1000/(2.93 + 10)$$
$$= \underline{77}\text{: SCS Curve Number}$$

C. Project surface storage

1. Assumptions

   a. Lake storage begins at a control elevation which is the given 5.5' NGVD.

   b. Lake storage is vertical over the 10 acres of lake surface area.

   c. Site storage is linear, starting at the minimum road elevation of 9.0' NGVD up through 12.0' NGVD.

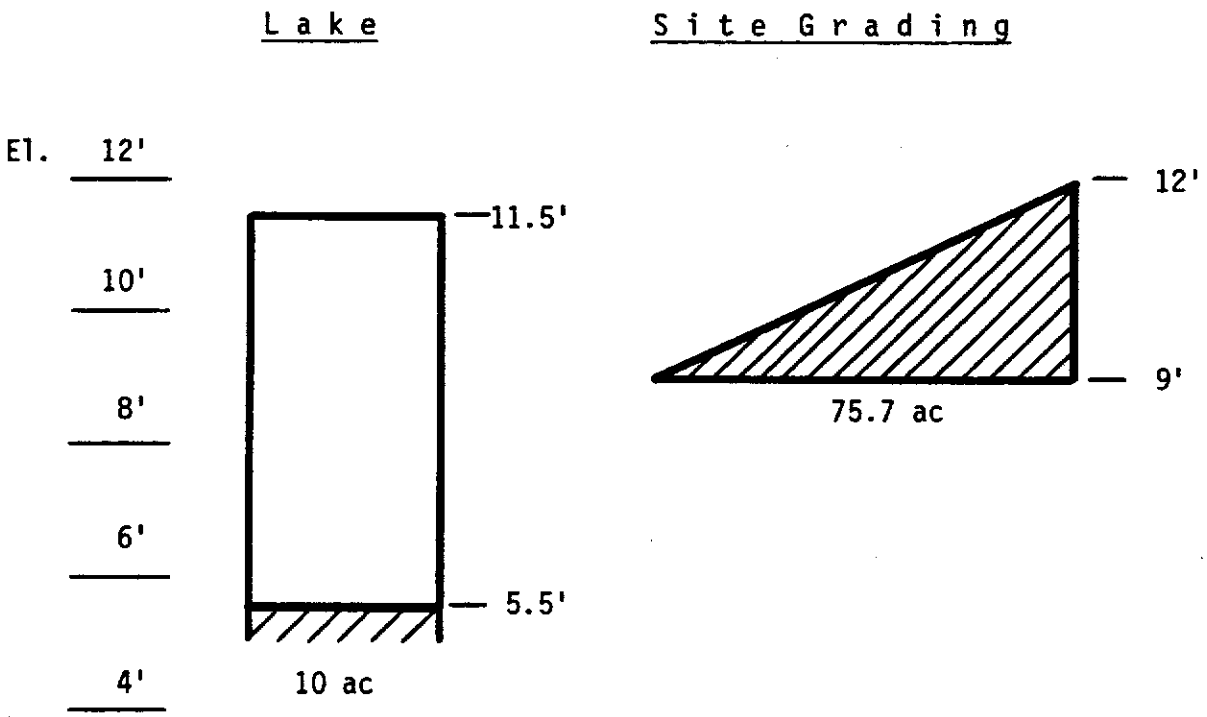
   d. Area of developed site grading:

   = Total area - (lakes + buildings)

   = 95 ac - (10 ac + 9.3 ac)

   = 75.7 ac for developed site grading.

2. Stage-Storage Schematic Diagrams



3. Stage-storage curve data

Stage (ft-NGVD)	Storage: Lake (ac-ft)	Storage: Site Grading (ac-ft)	Storage: Total (ac-ft)
5.5	0' x 10 ac = 0	0	0
6.5	1' x 10 ac = 10	0	10
7.5	2' x 10 ac = 20	0	20
8.5	3' x 10 ac = 30	0	30
9.0	3.5' x 10 ac = 35	0	35
9.5	4' x 10 ac = 40	((0.5/3) x 75.7ac) x (0.5ft/2) = 3.2	43.2
10.0	4.5' x 10 ac = 45	((1.0/3) x 75.7ac) x (1.0ft/2) = 12.6	57.6
10.5	5' x 10 ac = 50	((1.5/3) x 75.7ac) x (1.5ft/2) = 28.4	78.4
11.0	5.5' x 10 ac = 55	((2.0/3) x 75.7ac) x (2.0ft/2) = 50.5	105.5
11.5	6' x 10 ac = 60	((2.5/3) x 75.7ac) x (2.5ft/2) = 78.8	138.8

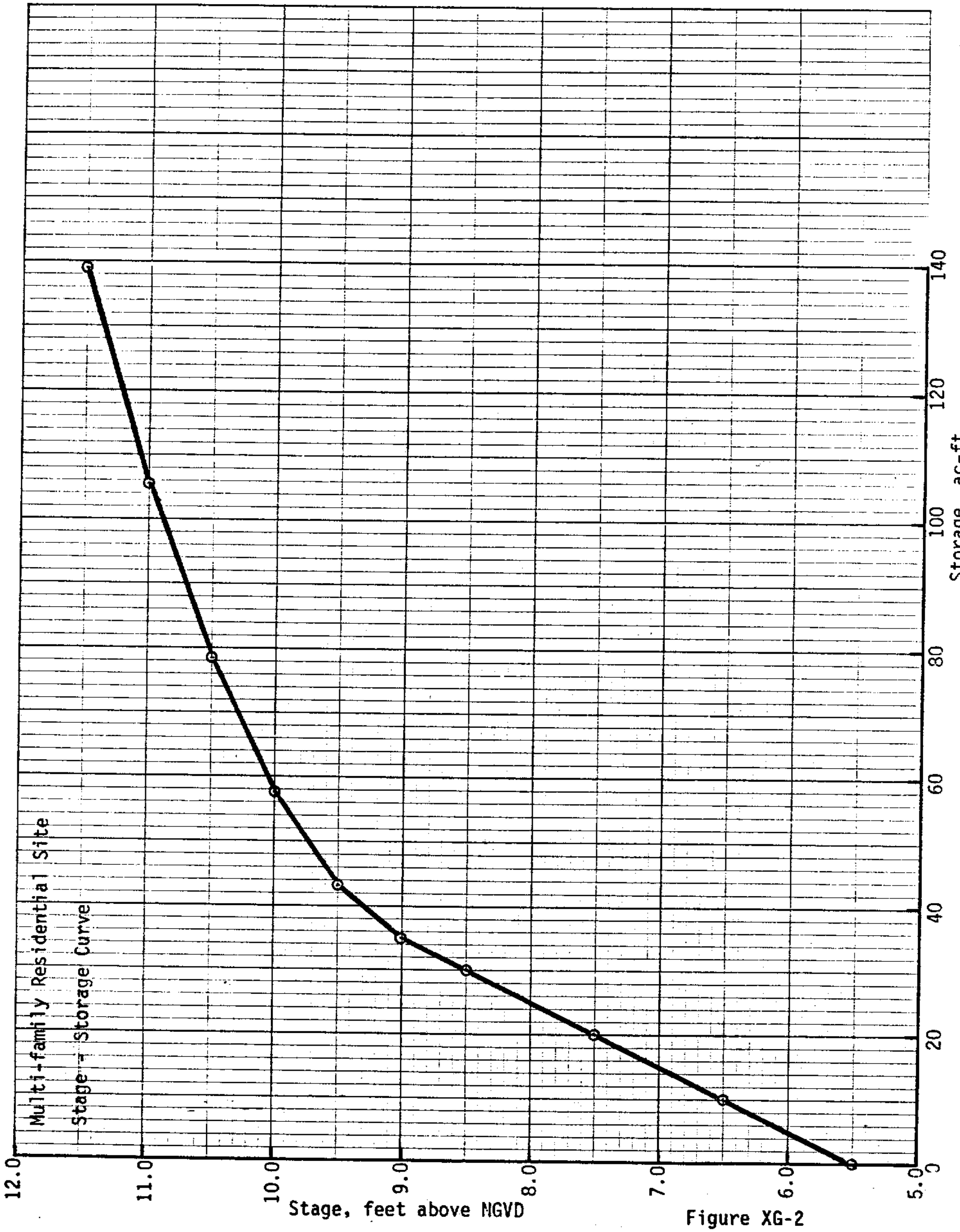

Multi-family Residential Site
Stage - Storage Curve
Storage, ac-ft
0
20
40
60
80
100
120
140
Stage, feet above NGVD
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0

Figure XG-2

D. Control structure weir crest elevation.

1. Set the crest high enough to store the required quality volume of 9.8 ac-ft.

2. From the stage-storage curve, the weir crest should be set at elevation 6.5' NGVD.

E. Control structure weir crest length.

1. Runoff from the design storm (25-year 3-day).

   a. Rainfall amount for a three-day event

      = 1-day rainfall x 1.359

      = 11.0 in. x 1.359

      = 14.95 in. rainfall in three days.

   b. Runoff in inches (Q)

      $$Q = (P - (0.2 \times S))^2/(P + (0.8 \times S))$$

      $$= \frac{(14.95 \text{ in.} - (0.2 \times 2.93 \text{ in.}))^2}{(14.95 \text{ in.} + (0.8 \times 2.93 \text{ in.}))}$$

      $$= (14.95 \text{ in.} - 0.59 \text{ in.})^2/(14.95 \text{ in.} + 2.34 \text{ in.})$$

      $$= (14.36 \text{ in.})^2/17.29 \text{ in.}$$

      = 11.9 in. of runoff from the 25-year 3-day storm.

   c. Runoff volume

      = inches of runoff x site area

      = 11.9 in. x 95 ac x 1 ft/12 in.

      = 94.2 ac-ft runoff volume.

2. The zero-discharge stage corresponding to 94.2 ac-ft is 10.8' NGVD.

3. The maximum design head would then be 10.8' NGVD - 6.5' NGVD = 4.3'. Therefore, try a design head of 4.0 ft for sizing the weir.

4. Compute weir length.

   a. Basic equation is $Q = 3.13LH^{1.5}$.

   b. Rearranged basic equation is $L = Q/(3.13 \times (H)^{1.5})$

      where: L = weir length, ft

      Q = design discharge, cfs

      H = design head on weir, ft

c. If Q = 37 cfs and H = 4 ft, then

$$L = 37 \text{ cfs}/(3.13 \times (4 \text{ ft})^{1.5})$$
$$= 37/(3.13 \times 8.0)$$
$$= 37/25.04$$
= say, 1.5 ft weir length.

F. Size the control structure detention discharge weir.

1. Criteria

   a. A V-notch is desirable.

   b. A triangular or circular orifice may be necessary.

   c. Size the weir (or orifice), to discharge no more than 0.5 inch of the detention volume in 24 hours.

2. Volume to be discharged in the first 24 hours is 0.5 inch of the required detention

   = 0.5 in. x (total site - lakes)

   = 0.5 in. x (95 ac - 10 ac) x 1 ft/12 in.

   = 3.5 ac-ft.

3. Design head

   = weir crest elevation - control elevation

   = 6.5' NGVD - 5.5' NGVD

   = 1 ft.

4. From the "Required V-Notch Size" design aid, for a total head of 1 ft and a desired detention volume of 3.5 ac-ft to be discharged in 24 hours, an angle of about 120 degrees is required.

   This would result in a V-notch weir with a width at elevation 6.5' NGVD greater than the 1.5 ft required for the sharp-crested weir. For various reasons, it is deemed unacceptable to alter other segments of the project until all reasonable control structure design possibilities have been exhausted.

   One approach is to utilize the 1.5-ft long sharp-crested weir and a V-notch weir with an angle considerably less than the 120° required to obtain the maximum discharge rate of the required quality detention volume. This will result in a maximum discharge rate less than that allowed.

   Since the minimum acceptable V-notch invert angle is 20°, the structure will incorporate that feature.

5. In order to avoid culvert control of the discharge, the outfall pipe from the control structure to the receiving body is recommended to be sized so as to pass the allowable design flow at about one-half of the estimated design head. For this project, the design head is four feet, so the culvert will be sized to pass 37 cfs at two feet of head along about 400 l.f. of circular concrete pipe flowing full. From other sources, a 30" diameter culvert should be sufficient.

6. The outfall structure will consist of a baffle, a 20^{0} V-notch weir, a 1.5 ft long sharp-crested weir, and 400 l.f. of RCP culvert, as shown in Figure XG-3 .

G. Values of stage-discharge for the control structure are shown in the computer printouts at the end of this example.

IV. Check storm stages and discharges.

A. Minimum building floor elevation.

1. The rainfall of the 100-year 3-day storm

= (1-day amount) x 1.359

= 14.0 in. X 1.359

= <u>19.0 in.</u>

2. Inches of runoff, Q

$= (P - (0.2 \times S))^2/(P + (0.8 \times S))$

$= (19.0\text{ in.} - (0.2 \times 2.93\text{ in.}))^2/(19.0\text{ in.} + (0.8 \times 2.93\text{ in.}))$

$= (19.0\text{ in.} - 0.6\text{ in.})^2/(19.0\text{ in.} + 2.3\text{ in.})$

$= (18.4\text{ in.})^2/21.3\text{ in.}$

= <u>15.89 in.</u> of runoff.

3. Volume of runoff

= (in. of runoff) x (project area)

= 15.89 in. x 95 ac x 1 ft/12 in.

= <u>125.8 ac-ft</u> required storage (zero discharge).

4. From the stage-storage curve, 125.8 ac-ft corresponds to an elevation of 11.3' NGVD. Since the proposed minimum floor elevation is 11.5' NGVD,

<u>the proposed minimum floor is acceptable</u>.

MULTI-FAMILY RESIDENTIAL SITE OUTFALL STRUCTURE
(N . T . S .)

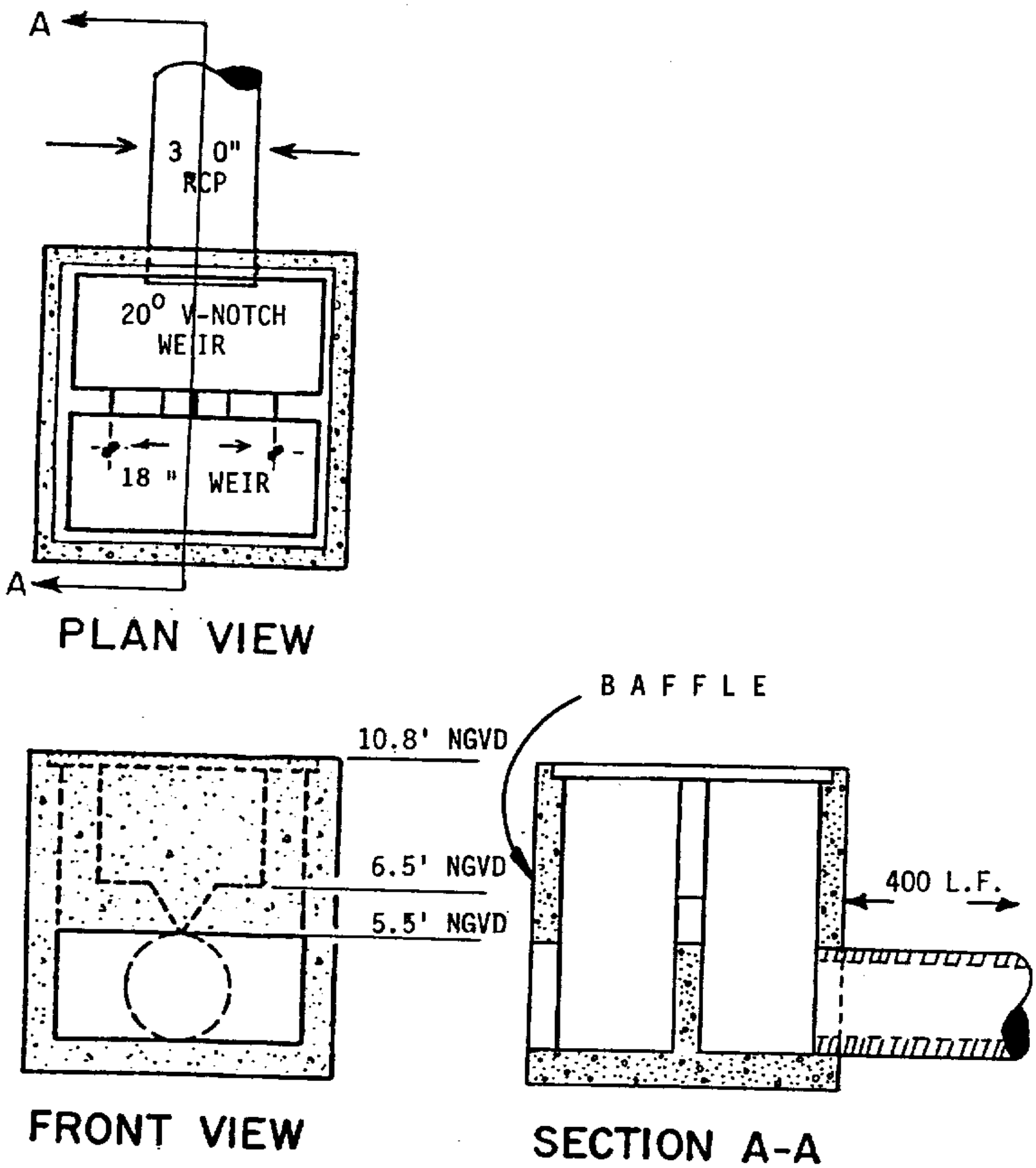


Figure XG-3

B. Roads versus local criteria

1. The minimum road grade must be at least 2 feet above control elevation, which is 5.5' NGVD. Since minimum proposed road elevation is 9.0' NGVD, the criteria is satisfied.

2. The minimum road grade must also be no lower than the peak of the 10-year 1-day storm, a local criteria. From the flood routing of that event, a peak elevation of 9.0' NGVD (to the nearest tenth of a foot) will occur. Since the proposed minimum road elevation is 9.0' NGVD,

<u>the proposed minimum road elevation is acceptable.</u>

C. Allowable peak discharge

1. The allowable peak discharge is 37 cfs. From the flood routing of that event, a peak discharge of 35.3, say, 35 cfs will occur. Since the routed peak discharge is less than that allowed,

<u>the proposed outfall structure design is adequate.</u>

WEIR LENGTH	1.5 FT.
WEIR ELEVATION	6.5 FT. NGVD
WEIR COEFFICIENT	3.13
TYPE OF BLEEDER SLOT	V-NOTCH
SLOT INVERT ELEV.	5.5 FT. NGVD
NOTCH ANGLE	20 DEG.

PIPE DATA

DIAMETER	2.5 FT.
LENGTH	400 FT.
N-VALUE	.012

STAGE	WEIR FLOW IN CFS WEIR	BLEEDER	TOTAL	PIPE FLOW	FLOW
5.50	0.00	0.00	0.00	.00	.00
6.00	0.00	0.09	0.09	12.94	9.100001E-0
6.50	0.00	0.49	0.49	18.29	.49
7.00	1.66	0.77	2.43	22.41	2.43
7.50	4.70	0.98	5.68	25.87	5.68
8.00	8.63	1.15	9.78	28.93	9.78
8.50	13.28	1.29	14.57	31.69	14.57
9.00	18.56	1.42	19.98	34.22	19.98
9.50	24.40	1.55	25.95	36.59	25.95
10.00	30.74	1.66	32.40	38.81	32.40
10.50	37.56	1.76	39.32	40.91	39.32

PROJECT NAME . . . . . : multi-family residential
REVIEWER . . . . : ah
PROJECT AREA . . . . . : 95.00 ACRES
GROUND STORAGE . . . . : 2.93 INCHES
TERMINATION DISCHARGE : 10.00 CFS
DISTRIBUTION TYPE . . : SFWMD
RETURN FREQUENCY . . : 10.00 YEARS
RAINFALL DURATION . . : 1-DAY
24-HOUR RAINFALL . . : 9.00 INCHES
REPORTING SEQUENCE . : STANDARDIZED

STAGE (FT)	STORAGE (AF)	DISCHARGE (CFS)
5.50	.00	.00
6.00	5.00	.09
6.50	10.00	.49
7.00	15.00	2.43
8.00	25.00	9.78
9.00	35.00	19.98
9.50	43.20	25.95
10.00	57.60	32.40
10.50	78.40	39.32

					- - - - - - - R E S E R V O I R - - - - - -				
TIME (HR)	RAIN FALL (IN)	ACCUM. RUNOFF (IN)	BASIN DISCHGE (CFS)	ACCUM. INFLOW (AF)	VOLUME (AF)	ACCUM. OUTFLOW (AF)	INSTANT DISCHGE (CFS)	AVERAGE DISCHGE (CFS)	STAGE (FT)
.00	.00	.00	.0	.0	.0	.0	.0	.0	5.50
4.00	.41	.00	.0	.0	.0	.0	.0	.0	5.50
8.00	1.23	.12	.0	.9	.9	.0	.0	.0	5.58
10.00	1.92	.42	.0	3.3	3.3	.0	.1	.0	5.81
11.00	2.42	.71	.0	5.6	5.6	.0	.1	.1	6.02
11.50	2.87	1.00	.0	7.9	7.9	.0	.3	.2	6.23
11.75	4.22	2.01	.0	15.9	15.9	.0	1.2	.7	6.69
12.00	5.90	3.43	.0	27.1	27.0	.1	7.1	4.2	7.64
12.50	6.56	4.01	.0	31.7	31.1	.6	14.8	11.9	8.50
13.00	6.90	4.32	.0	34.2	32.9	1.3	17.2	16.2	8.73
14.00	7.36	4.73	.0	37.4	34.6	2.8	19.2	18.4	8.93
16.00	7.92	5.24	.0	41.5	35.4	6.1	20.1	19.8	9.01
20.00	8.57	5.84	.0	46.2	33.8	12.4	18.6	19.3	8.86
24.00	9.00	6.24	.0	49.4	31.2	18.2	16.0	17.2	8.61
29.75	9.00	6.24	.0	49.4	25.2	24.2	9.9	12.8	8.02

SUMMARY INFORMATION

MAXIMUM STAGE WAS 9.01 FEET AT 16.00 HOURS
MAXIMUM DISCHARGE WAS 20.1 CFS AT 16.00 HOURS

PROJECT NAME . . . . . : multi-family residential
REVIEWER . . . . : ah
PROJECT AREA . . . . . : 95.00 ACRES
GROUND STORAGE . . . . : 2.93 INCHES
TERMINATION DISCHARGE : 10.00 CFS
DISTRIBUTION TYPE . . : SFWMD
RETURN FREQUENCY . . : 25.00 YEARS
RAINFALL DURATION . . : 3-DAY
24-HOUR RAINFALL . . : 11.00 INCHES
REPORTING SEQUENCE . : STANDARDIZED

STAGE (FT)	STORAGE (AF)	DISCHARGE (CFS)
5.50	.00	.00
6.00	5.00	.09
6.50	10.00	.49
7.00	15.00	2.43
8.00	25.00	9.78
9.00	35.00	19.98
9.50	43.20	25.95
10.00	57.60	32.40
10.50	78.40	39.32

TIME (HR)	RAIN FALL (IN)	ACCUM. RUNOFF (IN)	BASIN DISCHGE (CFS)	ACCUM. INFLOW (AF)	RESERVOIR VOLUME (AF)	RESERVOIR ACCUM. OUTFLOW (AF)	RESERVOIR INSTANT DISCHGE (CFS)	RESERVOIR AVERAGE DISCHGE (CFS)	RESERVOIR STAGE (FT)
.00	.00	.00	.0	.0	.0	.0	.0	.0	5.50
4.00	.27	.00	.0	.0	.0	.0	.0	.0	5.50
8.00	.54	.00	.0	.0	.0	.0	.0	.0	5.50
12.00	.80	.01	.0	.1	.1	.0	.0	.0	5.51
16.00	1.07	.07	.0	.5	.5	.0	.0	.0	5.55
20.00	1.34	.15	.0	1.2	1.2	.0	.0	.0	5.62
24.00	1.61	.26	.0	2.1	2.1	.0	.0	.0	5.70
28.00	2.00	.46	.0	3.6	3.6	.0	.1	.0	5.85
32.00	2.39	.69	.0	5.4	5.4	.0	.1	.1	6.03
36.00	2.78	.94	.0	7.4	7.3	.1	.3	.2	6.22
40.00	3.17	1.21	.0	9.6	9.3	.3	.4	.3	6.43
44.00	3.56	1.50	.0	11.9	11.4	.5	1.0	.6	6.63
48.00	3.95	1.80	.0	14.2	13.3	.9	1.7	1.4	6.82
52.00	4.44	2.19	.0	17.4	15.7	1.7	2.9	2.2	7.06
56.00	5.46	3.04	.0	24.1	20.9	3.2	6.6	4.5	7.57
58.00	6.29	3.77	.0	29.8	25.4	4.4	9.8	8.1	8.00
59.00	6.91	4.32	.0	34.2	28.8	5.4	13.0	11.3	8.32

TIME (HR)	RAIN FALL (IN)	ACCUM. RUNOFF (IN)	BASIN DISCHGE (CFS)	ACCUM. INFLOW (AF)	RESERVOIR VOLUME (AF)	RESERVOIR ACCUM. OUTFLOW (AF)	RESERVOIR INSTANT DISCHGE (CFS)	RESERVOIR AVERAGE DISCHGE (CFS)	RESERVOIR STAGE (FT)
59.50	7.46	4.82	.0	38.1	32.2	5.9	16.1	14.5	8.62
59.75	9.11	6.34	.0	50.2	43.8	6.4	22.0	19.0	9.17
60.00	11.16	8.28	.0	65.6	58.7	6.9	29.4	25.7	9.77
60.50	11.97	9.05	.0	71.7	63.4	8.3	33.8	32.3	10.10
61.00	12.39	9.45	.0	74.8	65.2	9.6	34.7	34.3	10.16
62.00	12.95	9.99	.0	79.1	66.6	12.5	35.2	35.0	10.20
64.00	13.63	10.65	.0	84.3	65.9	18.4	35.1	35.2	10.19
68.00	14.42	11.42	.0	90.4	60.7	29.7	33.4	34.2	10.07
72.00	14.95	11.93	.0	94.4	54.1	40.3	30.8	32.2	9.88
80.00	14.95	11.93	.0	94.4	36.7	57.7	21.2	26.3	9.11
88.00	14.95	11.93	.0	94.4	26.3	68.1	11.1	15.8	8.13
89.25	14.95	11.93	.0	94.4	25.2	69.2	10.0	10.5	8.02

SUMMARY INFORMATION

MAXIMUM STAGE WAS 10.21 FEET AT 62.25 HOURS
MAXIMUM DISCHARGE WAS 35.3 CFS AT 62.25 HOURS

Design Example
for
Distance from Public Water Supply Wells

DESIGN EXAMPLE

FOR

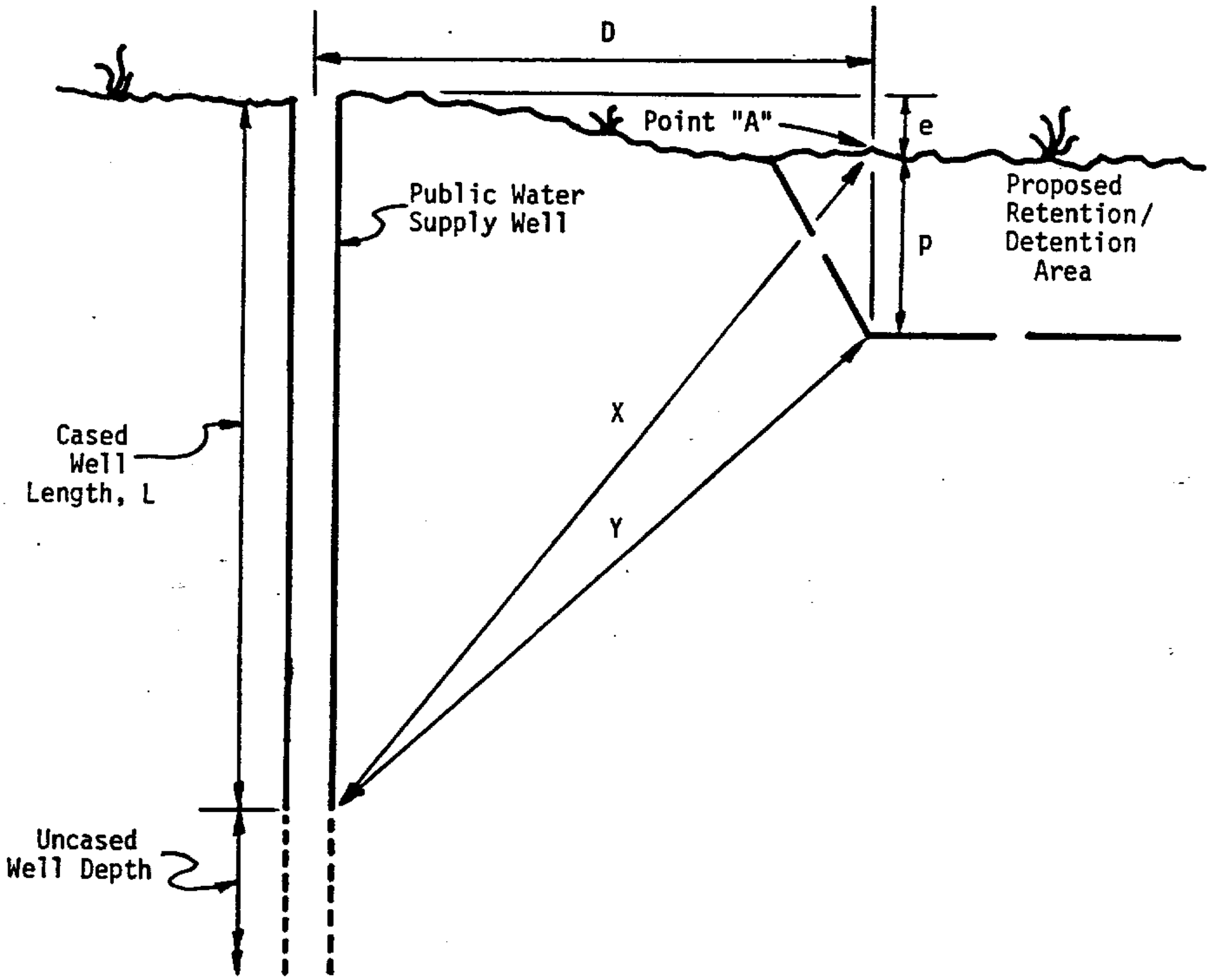
DISTANCE FROM PUBLIC WATER SUPPLY WELLS

In paragraph 5.2.2(e) of the *Basis of Review*, it is stated that:

> Retention/detention area locations shall not reduce hydraulic recharge distances to public water supply wells in excess of 2 percent nor shall wet retention/detention areas be closer to public water supply wells than 300 feet.

Given below is an example of how to incorporate this criteria.

SITE ELEVATION VIEW
N.T.S.



I. Given

A. A public water supply well.

1. Cased a known length, L.

2. At a known ground surface elevation.

B. A proposed retention/detention area with a proposed maximum depth, p, measured at Point "A" nearest the well.

C. A difference, e, in elevation between the well top and Point "A."

D. No aquiclude interference.

II. Required

A. That D be at least 300 feet.

B. That Y be greater than, or equal to, 0.98 of X.

III. Computations

A. To assure that D be at least 300 feet is simply a matter of properly positioning the various elements of the project within the site.

B. Check that Y is greater than, or equal to, 0.98X.

1. Compute distance X.

a. If Point "A" is lower than the well top:
From the trigonometry of a right triangle:

$$X^2 = (L-e)^2 + D^2$$

so: $X = ((L-e)^2 + D^2)^{0.5}$

b. If Point "A" is higher than the well top:
From the trigonometry of a right triangle:

$$X^2 = (L+e)^2 + D^2$$

so: $X = ((L+e)^2 + D^2)^{0.5}$

2. Compute distance Y

a. If Point "A" is lower than the well top:
From the trigonometry of a right triangle:

$$Y^2 = (L - (p + e))^2 + D^2$$

so: $Y = ((L - (p + e))^2 + D^2)^{0.5}$

b. If Point "A" is higher than the well top:
From the trigonometry of a right triangle:

$$Y^2 = (L - (p - e))^2 + D^2$$

so: $$Y = ((L - (p - e))^2 + D^2)^{0.5}$$

3. Compute 0.98 of Distance X.

4. If Y is greater than, or equal to, 0.98X, the retention/detention depth and location meet the criteria of paragraph 5.2.2(e).

5. If Y is less than 0.98X, a redesign of the retention/detention area is required. This could involve - among other things - any, or all, of the following:

    a. Move the area farther from the well.

    b. Move the area to a place with different ground elevations.

    c. Design the lake less deep.